An overview of the Digital Communications Processes Part II

05/01/05

1. Signal Flow in a digital station:

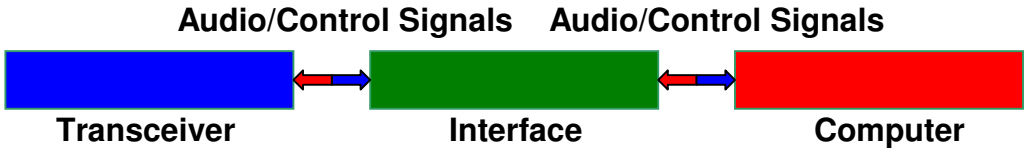

Figure 2

- **Transceiver**
  - A radio transmitter/receiver combination used to construct the “Channel”, (Physical Layer), in a communications System as defined in Part I.

- **Interface**
  - A device which takes signals from the Computer and the transceiver and processes them in such a way as to match the levels, avoid ground loops, control the transceiver using either a serial control network, or simple PTT relay closure. This device should also impedance match, and isolate the computer from the radio.

- **Computer**
  - A device used to control various functions of station operation

- **Software**
  - A product which will take signals from the radio, as presented to the computer via the Interface, and either decode, or encode them into audio for transmission by the Transceiver.

New Communications System including Digital items and Human

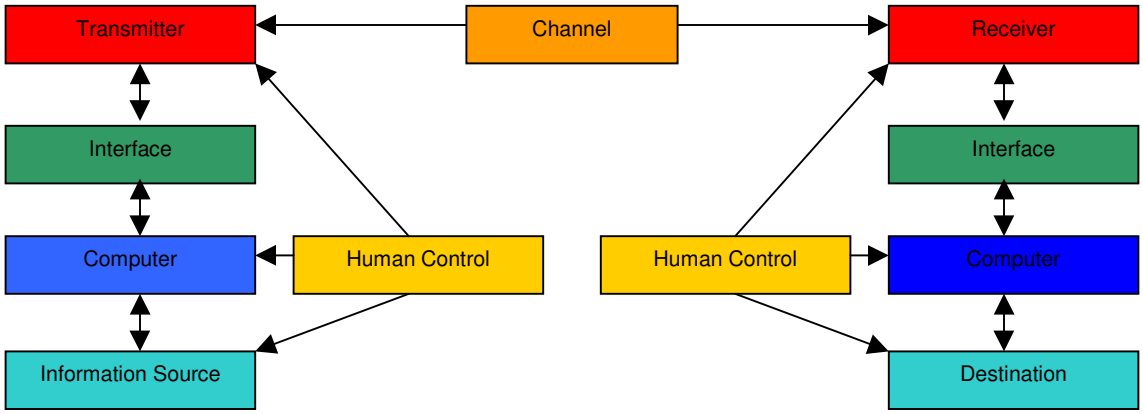

Figure 3
An expanded version of the "Communications System" shown in part I, including the human and the digital components.

- **Information Source**
  - Creates the Message
- **Computer**
  - Accepts the message from the "Information Source, and codifies it, creates the needed tones, and controls the transmitter
- **Interface**
  - Takes the message and control signals from the Computer and converts them into signals the transceiver can read
- **Transmitter**
  - Takes the Audio, and control signals supplied by the Interface and transmits the data via whatever mode is set by the computer. The transmitter just transmits audio from the computer after signal conditioning by the Interface.
- **Channel**
  - This is the medium by which we choose to carry the message, in MARS it is normally radio waves.

- **Step by step of a message transmission**

1. The message is created by the Information source, or the Human control operator, they may or may not be the same person, or device.

2. The Human places the message in the computer, either by typing it, uploading, or reading a pre built file, such as a .txt file created with notepad. it to the computer.

3. The computer codes the message and controls the transmitter to send it.

4. The message is transmitted using the sound card of the computer via the Interface to the transmitter.

5. The Receiver collects the message.

6. The audio from the receiver is fed to the Interface.

7. The Interface converts the levels and matches the audio to the computer sound card.

8. The computer decodes the audio and displays the message.

9. The human Operator passes the message to the Information Destination.

2. Hardware Comparison for digital [6,14]

- ***West Mountain Radio*** [4]

  - **Rigblaster *Nomic:***

    - **Pros**
      - Cost
      - Very Small
      - Less cables
      - No external power supply needed great for portable or QRP installations.

    - **Cons**
      - Does not do as much as others
      - Less Isolation
      - Does not handle external Microphones

- **Rigblaster Plus [6]:**
  - **Pros**
    - Cost
    - Fully automatic operation of your microphone. Always works, your computer always works no manual switching, no plugging or unplugging.
    - Simpler operation than the other brands, you never have to remember to push UN-needed switches to make your station work.
    - PTT override feature; your microphone. Can always override the computer, perfect for contesting or SSTV operation.
    - Automatic switching between your microphone and the computer; never a hot microphone.
    - You may always leave it connected, everything always works, no bypass switch required.
    - In addition to the PTT keying circuit there is a fully isolated CW/FSK keying output for direct keying of your rig's CW or FSK jack for use with non-sound card software, no other interface has this.
    - Input for control of this additional fully isolated CW/FSK keying circuit as well as the PTT circuit is jumper selectable between serial port leads RTS, DTR, and TXD.
    - Internal diagnostic LEDs show at a glance what the serial port is doing with RTS, DTR and TXd, check if the other brand has this.
    - Rear panel RCA PTT switch / foot switch jack that enables the PPT override and interrupt, another exclusive.
    - Power supply included, no charge. Your choice of 120 VAC or 230 VAC
  - **Cons**
    - Less Performance

- **Rigblaster Pro:**
  - **Pros**
    - Rig control is possible along with sound card PTT control and CW keying on a SINGLE serial port using Hamscope or MixW software.
    - Single serial port pass through for radios directly RS232 controlled (newer Yaesu and Kenwood).
    - Your microphone may be bridged to computer as well as radio for on-the-fly digital recording.
    - Plug in 2nd microphone. jack allows instant automatic switch over to a headset microphone. without unplugging your main microphone.
    - Fully automatic operation; your microphone. Always works, your computer always works, no manual switching, no plugging or unplugging, ever.
    - Automatic switching between your microphone and the computer; never a hot microphone.
    - A RIGblaster pro may be connected all the time, everything always works, no bypass switches required. However with the RIGblaster pro power switch in the "OFF" position the process switch must also be "OFF" for your microphone to work through the RIGblaster pro.
    - Fully isolated FSK keying output for direct keying of your rig's FSK jack. This jack is for use with non-sound card software using serial TXD control.
    - Front panel audio drive control allows setting the transmit audio from the computer to your radio without fumbling with your mouse.
    - Total ground loop isolation using 3 shielded isolation transformers, 3 optoisolators, 3 relays and an isolating DC to DC converter.
  - **Cons**
    - Cost
    - Many more cables than any of the above, really only useful in a permanent home site.
    - Much more difficult to initially install.
    - Needs external Power Supply
    - Needs a Serial Port to work, some computers do not have serial ports. If your computer does not then will need to purchase and configure a USB to Serial adapter in addition to the interface unit.
    - The processor feature seems like a lot of work to create

- **Tigertronics [5,6]**
  - **Signal Link SL1:**
    - **Pros**
      - Size, very small and portable
      - Very good for portable use
      - Contains VOX so no Serial port needed
      - Good for portable or Laptop operation
    - **Cons**
      - No serial port, so radio status not possible with this device alone
  - **Signal Link SL1+:**
    - **Pros**
      - Contains a VOX circuit, so you don't have to configure the Serial ports.
      - Powered from Radio
      - Very Small in size
      - Very good for portable use
      - Does not need a serial port
      - Very good for emergency efforts due to the above features
      - Size, very small and portable
    - **Cons**
      - No serial Port, so multi devices will be needed if you want to read back radio status.

- **Home Built Cables:**
  - **Pros**
    - Almost no cost
    - If you have built things before, this is a simple task.
  - **Cons**
    - You must be able to solder, if you have not built things before, this may be a good project to start with. The problem is you are now adding another task to your learning curve.
    - In order to provide a reasonable amount of Isolation, (your transmitter can have hundreds of volts running around inside), you should use Opto-Isolators. This adds complexity to the project.
    - No serial port

3. The Modes:

- **MT-63** [10,11,12,13]
  A Half-Duplex, multi-frequency, PSK, synchronous, non-linked, error resistant mode.

  - **Pros**
    - Setup is easy
    - Setup is inexpensive
    - Lots of software available, freeware, and shareware
    - MT63 at 1000Hz is approximately two times faster than AMTOR
    - MT63 at 2000 Hz is approximately three times faster than AMTOR
    - MT63 works very well in poor conditions and while using low power
    - Tuning is not as critical as other modes.
    - The use of smart Macros
    - Fast mode copaired to RTTY
    - Uses a full 1 kHz, or 2 kHz, thus dispersing the signal to counter selective fading, and single carrier interference.
    - Designed to be restive to interference from the ground up.
    - Uses 64 tones. 64 Tones allows millions of combinations. When only 128 characters are used, the selection of which tones represent which character can be done in a way that so that they are statistically different from each other. This allows the software to “guess” better when it has not have received the full set of tones for a character.

  - **Cons**
    - MT63 is not ARQ (Yet)
    - MT63 will not talk to a MDS switch (Yet)
    - MT63 is 1 kHz wide, (not a big issue on MARS frequency)
    - Needs a bit of time to synchronize [13]
    - Not a linked mode, thus must be FECed.
    - Needs to synchronize, so quick back and forth are time consuming.

- **RTTY** [12,13, 15]
  A Half duplex, FSK, asynchronous non-linked, non-error corrected mode.

  - **Pros**
    - Setup is easy
    - Setup Is inexpensive
    - Narrow Bandwidth means less power
    - Lots of software available, freeware, and shareware
    - Lots of people know how to run RTTY traffic
    - Lots of people run RTTY, so practice is easy
    - The use of smart Macros
    - Does not need to synchronize, so quick back and forth transmissions are possible
    - No Handshaking, so all stations can copy at once.

  - **Cons**
    - No error correction at all
    - Single burst of static will destroy content with no hope of recovery
    - Upper case only
    - Slow mode compared to MT63 2K
    - 100% Key Down on the transmitter

- **AMTOR Mode B, or AMTOR FEC [15]**
  A Half-duplex, FSK, synchronous, non-linked, error resistant mode. Two modes, mode A is ARQ corrected, and mode B is FEC corrected.

  - Pros
    - Setup is easy
    - Setup is inexpensive
    - Lots of software available, freeware, and shareware
    - Based on SITOR
    - Each character is transmitted twice, and there is no ARQ.
    - Works where AMTOR Mode A will not
    - More reliable than RTTY

  - Cons
    - Not all errors are corrected, not as reliable as AMTOR Mode A
    - Not a linked mode
    - Needs to synchronize, so quick back and forth are time consuming.
    - 100% Key down on the transmitter

1. Available Software:

While there are many programs available for digital modes, only two will be looked at here for now. They are MixW, and MT63 Terminal. More will be added as time allows.

- **MixW [7] by UT2UZ and UU9JDR:**

  - **Pros:**
    - All current MARS FEC modes are supported in one package
    - Currently under development
    - Large user base
    - Support mail groups on Yahoo
    - Lots of Macros you can automate
    - What you learn for one mode applies to All modes.
    - Author has special registration for MARS users so two calls can be used, your Ham and your MARS call.
    - Built in Log capable of ADIF export
    - Color Waterfall Display

  - **Cons:**
    - Costs Money
    - Learning curve to get started

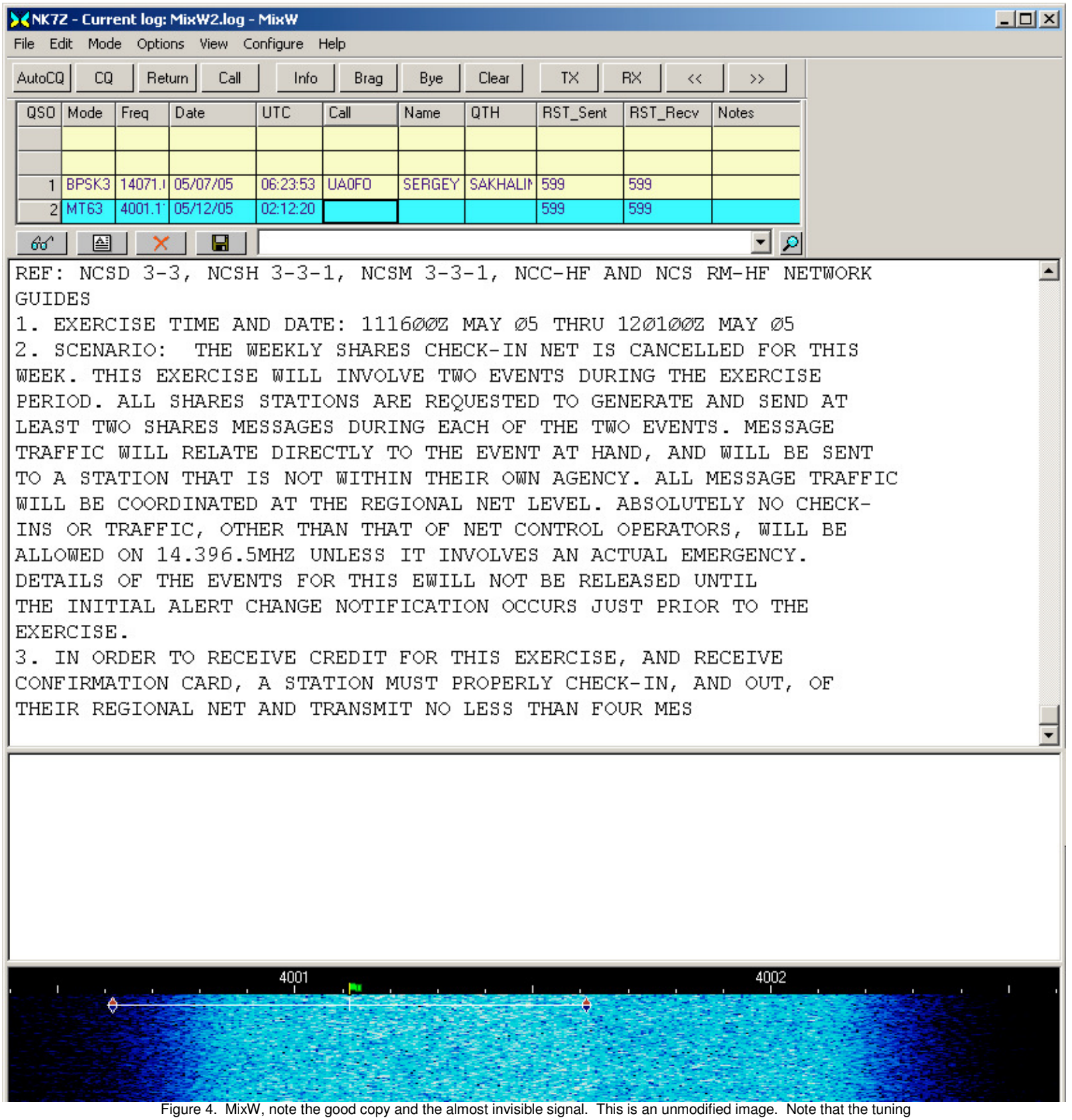
NK7Z - Current log: MixW2.log - MixW
File Edit Mode Options View Configure Help
AutoCQ CQ Return Call Info Brag Bye Clear TX RX << >>
QSO Mode Freq Date UTC Call Name QTH RST_Sent RST_Recv Notes
1 BPSK3 14071.0 05/07/05 06:23:53 UA0FO SERGEY SAKHALIN 599 599
2 MT63 4001.1 05/12/05 02:12:20 599 599
REF: NCSD 3-3, NCSH 3-3-1, NCSM 3-3-1, NCC-HF AND NCS RM-HF NETWORK GUIDES
1. EXERCISE TIME AND DATE: 1116ØØZ MAY Ø5 THRU 12Ø1ØØZ MAY Ø5
2. SCENARIO: THE WEEKLY SHARES CHECK-IN NET IS CANCELLED FOR THIS WEEK. THIS EXERCISE WILL INVOLVE TWO EVENTS DURING THE EXERCISE PERIOD. ALL SHARES STATIONS ARE REQUESTED TO GENERATE AND SEND AT LEAST TWO SHARES MESSAGES DURING EACH OF THE TWO EVENTS. MESSAGE TRAFFIC WILL RELATE DIRECTLY TO THE EVENT AT HAND, AND WILL BE SENT TO A STATION THAT IS NOT WITHIN THEIR OWN AGENCY. ALL MESSAGE TRAFFIC WILL BE COORDINATED AT THE REGIONAL NET LEVEL. ABSOLUTELY NO CHECK-INS OR TRAFFIC, OTHER THAN THAT OF NET CONTROL OPERATORS, WILL BE ALLOWED ON 14.396.5MHZ UNLESS IT INVOLVES AN ACTUAL EMERGENCY. DETAILS OF THE EVENTS FOR THIS EWILL NOT BE RELEASED UNTIL THE INITIAL ALERT CHANGE NOTIFICATION OCCURS JUST PRIOR TO THE EXERCISE.
3. IN ORDER TO RECEIVE CREDIT FOR THIS EXERCISE, AND RECEIVE CONFIRMATION CARD, A STATION MUST PROPERLY CHECK-IN, AND OUT, OF THEIR REGIONAL NET AND TRANSMIT NO LESS THAN FOUR MES
4001
4002

Figure 4. MixW, note the good copy and the almost invisible signal. This is an unmodified image. Note that the tuning indicator is not shown as it is on a floating window not captured.

- **MT63 Terminal [8] by IZ8BLY:**
  - **Pros**
    - Free
    - Some Macros
    - Support Mail groups in Yahoo
    - Simpler to set up than MixW
    - Simpler to operate than MixW
  - **Cons**
    - Single mode, MT63 only
    - You have to purchase, or install other software to be able to copy the two accepted modes for MARS digital
    - Needs a calculation for setting the sample frequency, not difficult, just one more step.
    - Less options than MixW
    - No Logging
    - Black and White Waterfall

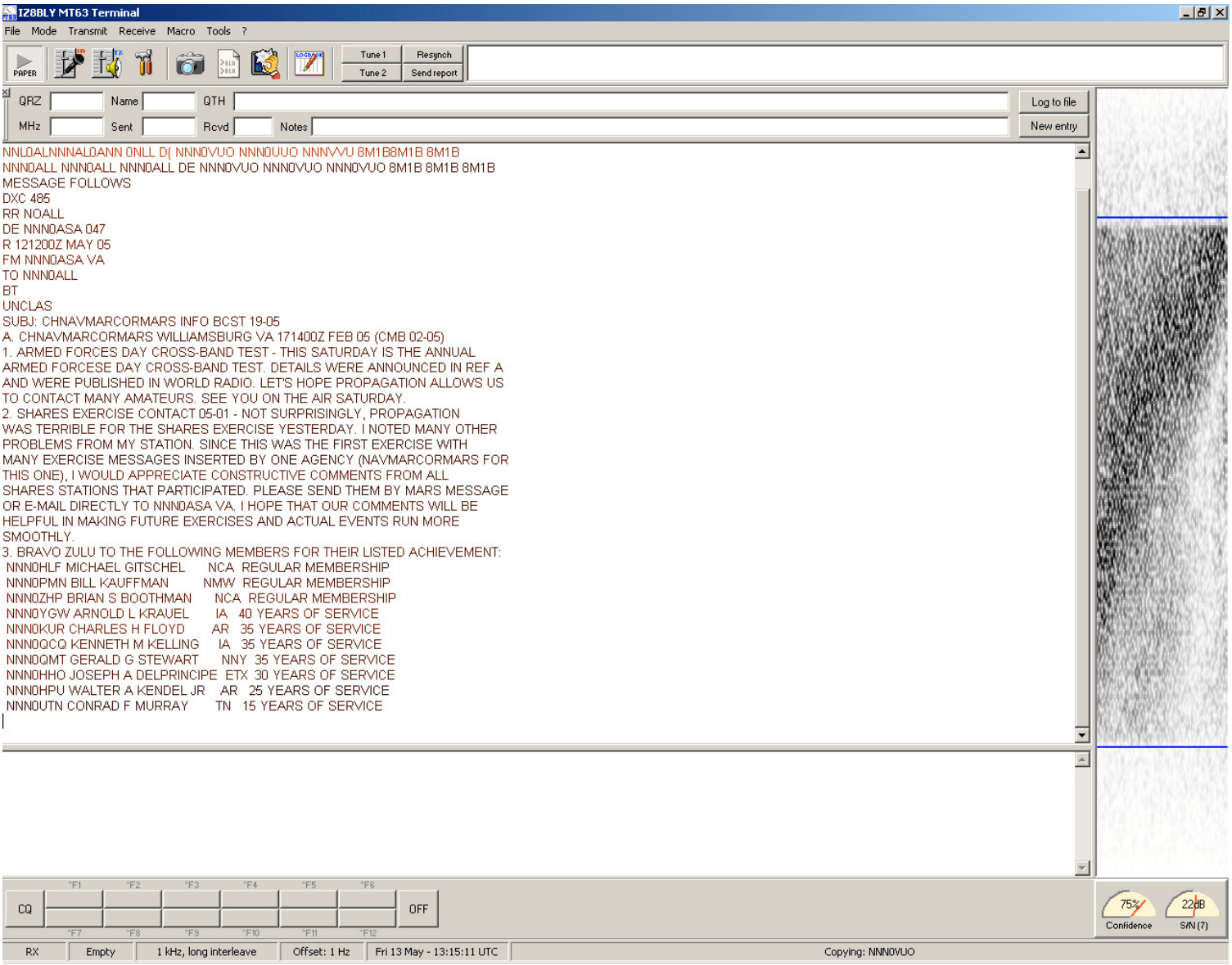
IZ8BLY MT63 Terminal
File Mode Transmit Receive Macro Tools ?
PAPER
Tune 1
Tune 2
Resynch
Send report
QRZ
Name
QTH
MHz
Sent
Rcvd
Notes
Log to file
New entry
NNL0ALNNNALOANN ONLL D(NNN0VUO NNN0UUO NNNVVU 8M1B8M1B 8M1B
NNN0ALL NNN0ALL NNN0ALL DE NNN0VUO NNN0VUO NNN0VUO 8M1B 8M1B 8M1B
MESSAGE FOLLOWS
DXC 485
RR NOALL
DE NNN0ASA 047
R 121200Z MAY 05
FM NNN0ASA VA
TO NNN0ALL
BT
UNCLAS
SUBJ: CHNAVMARCORMARS INFO BCST 19-05
A. CHNAVMARCORMARS WILLIAMSBURG VA 171400Z FEB 05 (CMB 02-05)
1. ARMED FORCES DAY CROSS-BAND TEST - THIS SATURDAY IS THE ANNUAL
ARMED FORCESE DAY CROSS-BAND TEST. DETAILS WERE ANNOUNCED IN REF A
AND WERE PUBLISHED IN WORLD RADIO. LET'S HOPE PROPAGATION ALLOWS US
TO CONTACT MANY AMATEURS. SEE YOU ON THE AIR SATURDAY.
2. SHARES EXERCISE CONTACT 05-01 - NOT SURPRISINGLY, PROPAGATION
WAS TERRIBLE FOR THE SHARES EXERCISE YESTERDAY. I NOTED MANY OTHER
PROBLEMS FROM MY STATION. SINCE THIS WAS THE FIRST EXERCISE WITH
MANY EXERCISE MESSAGES INSERTED BY ONE AGENCY (NAVMARCORMARS FOR
THIS ONE), I WOULD APPRECIATE CONSTRUCTIVE COMMENTS FROM ALL
SHARES STATIONS THAT PARTICIPATED. PLEASE SEND THEM BY MARS MESSAGE
OR E-MAIL DIRECTLY TO NNN0ASA VA. I HOPE THAT OUR COMMENTS WILL BE
HELPFUL IN MAKING FUTURE EXERCISES AND ACTUAL EVENTS RUN MORE
SMOOTHLY.
3. BRAVO ZULU TO THE FOLLOWING MEMBERS FOR THEIR LISTED ACHIEVEMENT:
NNN0HLF MICHAEL GITSCHEL NCA REGULAR MEMBERSHIP
NNN0PMN BILL KAUFFMAN NMW REGULAR MEMBERSHIP
NNN0ZHP BRIAN S BOOTHMAN NCA REGULAR MEMBERSHIP
NNN0YGW ARNOLD L KRAUEL IA 40 YEARS OF SERVICE
NNN0KUR CHARLES H FLOYD AR 35 YEARS OF SERVICE
NNN0QCQ KENNETH M KELLING IA 35 YEARS OF SERVICE
NNN0QMT GERALD G STEWART NNY 35 YEARS OF SERVICE
NNN0HHO JOSEPH A DELPRINCIPE ETX 30 YEARS OF SERVICE
NNN0HPU WALTER A KENDEL JR AR 25 YEARS OF SERVICE
NNN0UTN CONRAD F MURRAY TN 15 YEARS OF SERVICE
^F1 ^F2 ^F3 ^F4 ^F5 ^F6
CQ
OFF
^F7 ^F8 ^F9 ^F10 ^F11 ^F12
75%
Confidence
22dB
S/N (7)
RX
Empty
1 kHz, long interleave
Offset: 1 Hz
Fri 13 May - 13:15:11 UTC
Copying: NNN0VUO

Figure 5: MT63 Terminal showing normal operation

2. Setup of MixW [7]:

Generalized setup of MixW

- **File**
  There are no items to change under File

- **Edit**
  There are no items to change under Edit

- **Mode**
  Select whatever mode you wish to operate.

- **Options**
  Set as per your preferences, or take defaults at first.

- **View**
  Select Control Bar
  Select CAT Bar
  Select Tuning Indicator

- **Configure**
  Select Personal Data:
    Call
    Name
    QTH
    LAT/LONG
    CW ID

  Select Merge Macros

  Select TRCVR CAT/PTT:
    Normally select the type of Radio you have, and the Com port you are using. Take the rest as defaults.

- **Help**
  Read the Help Topics and then the rest of the help file

3. Setup of MT63 using MT63 Terminal:

- **File**

  Preferences

  Call Sign

  Sample Rate

1. Believe it or not, first you must set up MMSSTV
2. Install MMSSTV, and print out the instructions and read them.
3. Shut down all other programs you might have running, then start MMSSTV and select the OPTIONS pull down from the top tool bar.

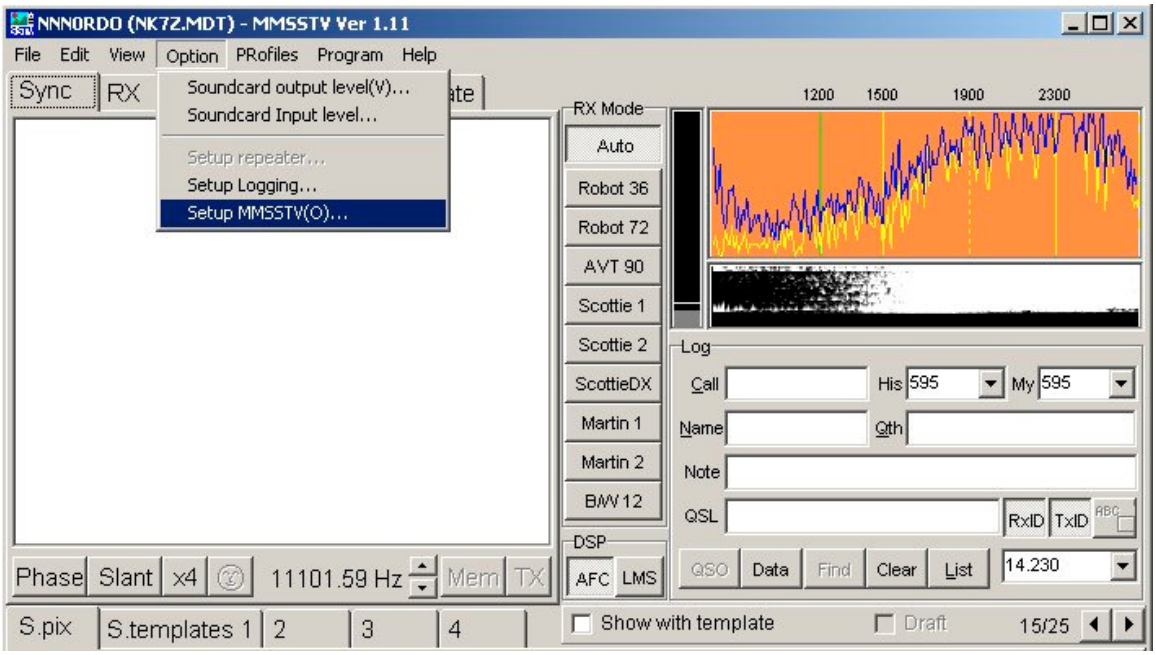

Figure 6

4. This bring up a three tabbed notebook, select the RX Tab.

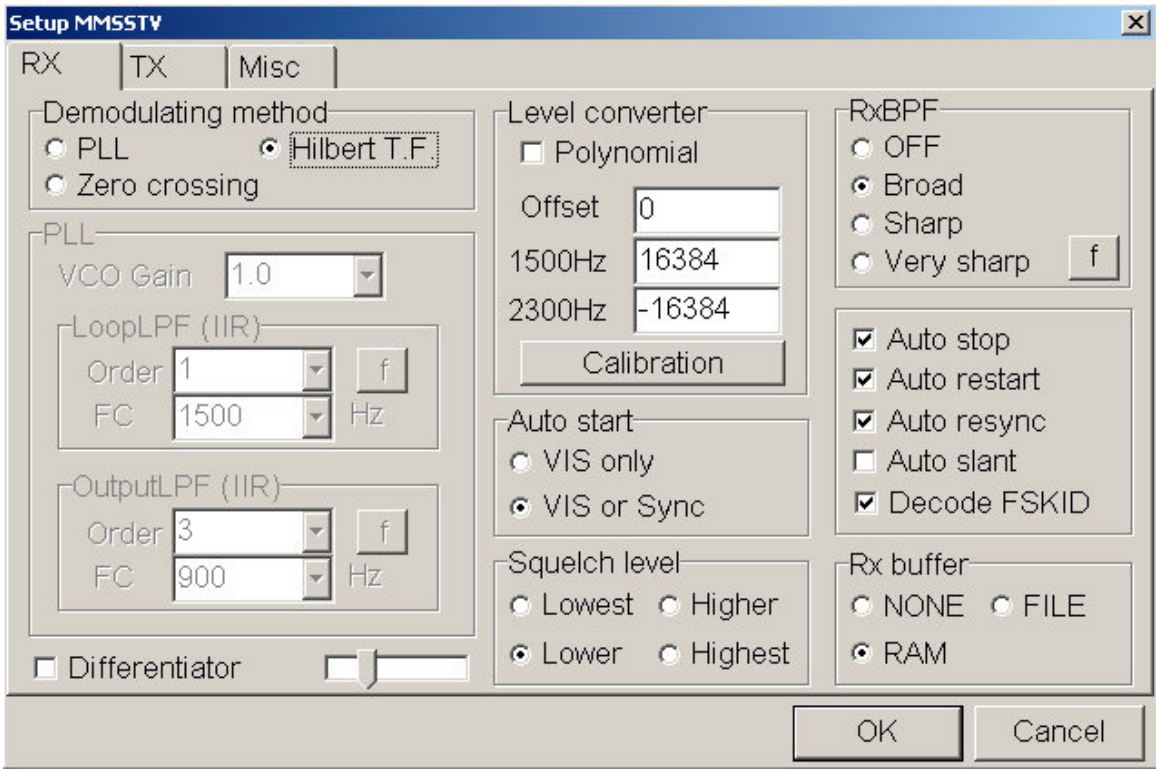

Figure 7

5. Set up the RX Page as follows; (DO NOT CHANGE THE LEVEL CONVERTER INFO):

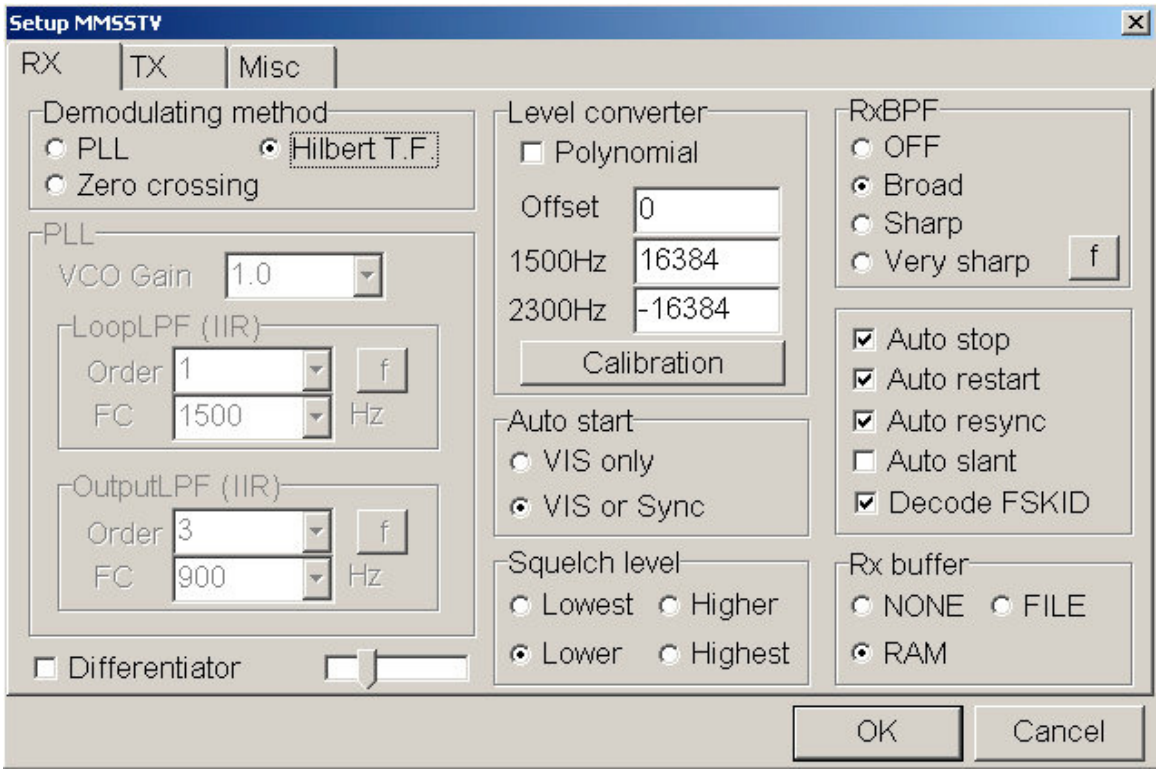

Figure 8

1. Setup the TX Page as follows, (DO NOT CHANGE THE TxBPF/TxLPF, TUNE BUTTON INFO, or PORT value):

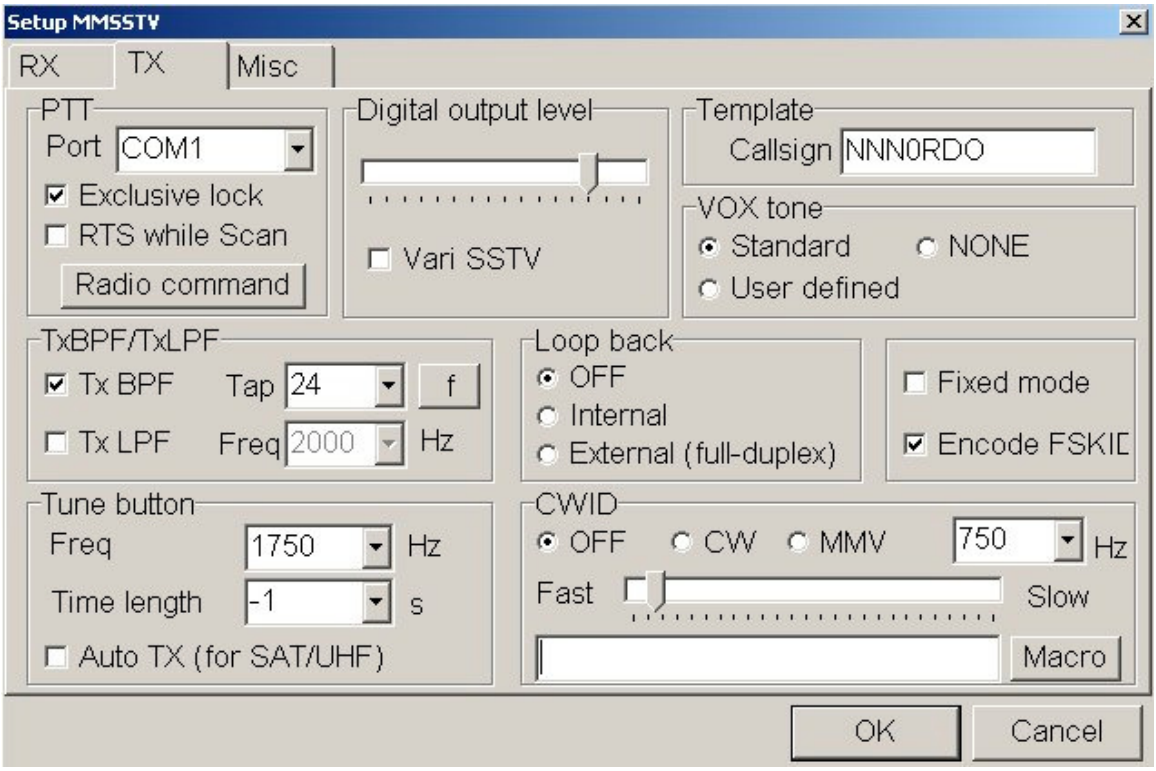

Figure 9

7. Set up the MISC page as follows, (DO NOT CHANGE THE FIFO, or DEVICE ID):

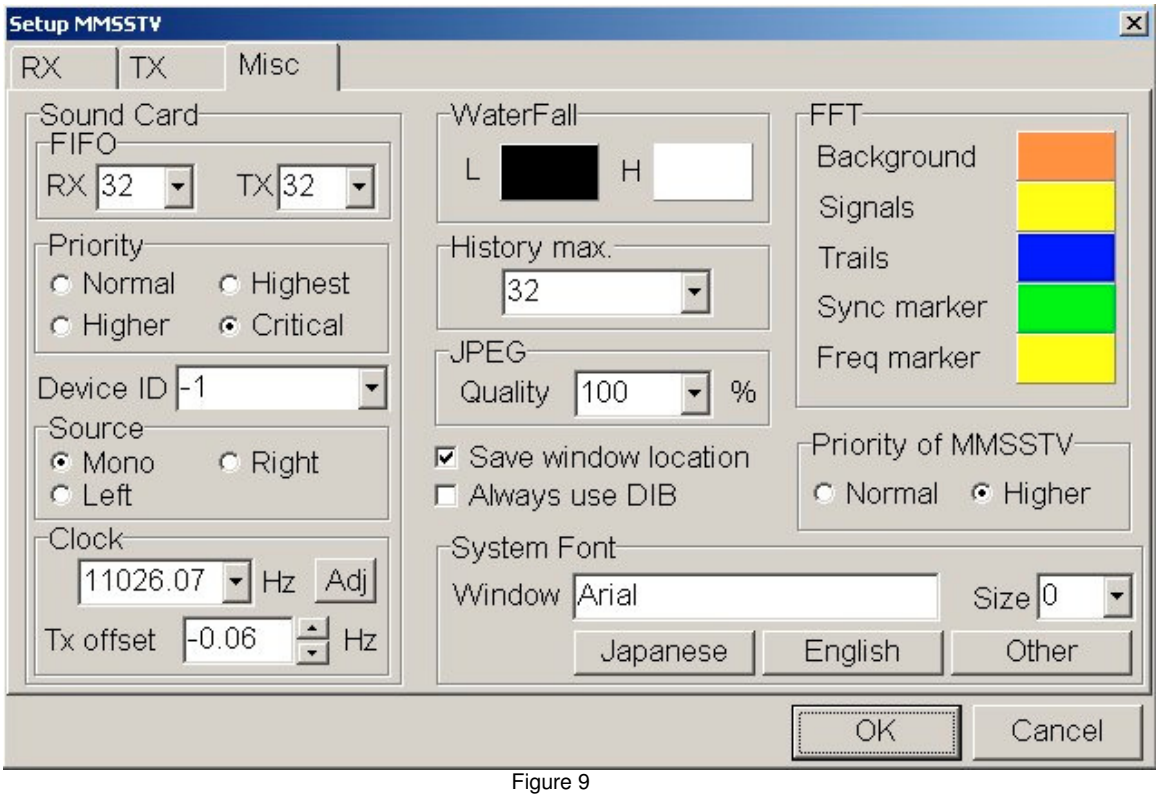

Figure 9

8. Note above: DO NOT change anything in the CLOCK window.
9. Once you have these items set up locate a station that believes they are calibrated correctly. They become the "Standard" for all.
10. Have them send a picture to you. After that picture is complete Select the "SYNC" tab, (you can do this while the picture is being received), then select the NICONICO (Happyface), button ONLY after the picture is complete. A number will appear in a small white box in the upper part of the screen. This is your error from the selected "Master" station.
11. You may press the "MEM" button. This will lock your computer to the "Master" stations clock frequency. Your receive is now setup.
12. Get the clock set frequency from the MISC Tab above and write it down.

13. Close MMSSTV and open the IZ8BLY MT63 Terminal. Now select the File/Preferences from the pull down. You will see this box:

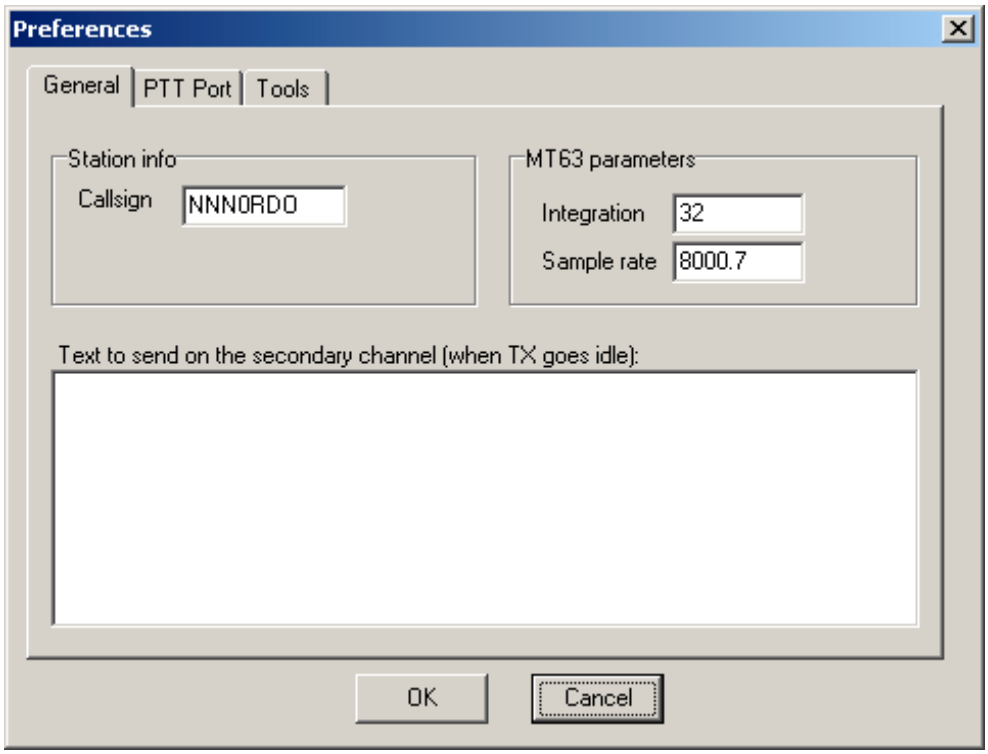

Figure 10

14. Divide the frequency by 11,025, and then take that number and multiply it by 8000, insert the result in the Sample Rate box. (Example: 11037/11025 = 1.00109. 8000 x 1.00109 = 8008.7)

- **PTT**
  Select the PTT Com port you need

- **Help**
  Read the Help file

2. **MARS Station Resource & Inventory:**

   - ***What stations as to what capability***
     - Poll stations on net in order to create a list of stations that believe themselves ready to transmit traffic.
     - Poll stations to determine which stations want to run Digital, but need assistance.
     - Poll stations on the net to create a list of Interface equipment. Used to develop a help list.
     - Poll Stations to create a list of helpers

3. Net Schedule:

   Second Friday
   - Setup and practice
     - Time before Training net, and after Traffic net Q and A
     - 0 to 15 Final Q and A or operation depending on number of Q's.
     - 15 to 00 Test transmissions and setup help

   Forth Friday
   - Additional Setup help followed by traffic passing between each other.

Terms

- **Linked:**

A transmission is linked when it is necessary for the receiving station to answer the transmitting station in order to continue transmissions.

Non-Linked:

A station is not linked when it is not necessary for the receiver to answer the transmitter.

- **Synchronous:**

A transmission technique for sending a unique set of bits to the receiver in order to allow the receiver to know where the start of data will begin during a transmission.

References

1. Bell Labs Technical Journal, Volume 27, Page 379-423 623-656 October 1948, A Mathematical Theory of Communications by C. E. Shannon. http://cm.bell-labs.com/cm/ms/what/shannonday/shannon1948.pdf
2. RFC 3452 - Forward Error Correction (FEC) Building Block http://www.faqs.org/rfcs/rfc3452.html.
3. All Clipart provided by Dave Cole.
4. West Mountain Radio http://www.westmountainradio.com. All information used from the Westmountain Radio Web Site.
5. Tigertronics http://www.tigertronics.com. All information used from the Tigertronics Web Site.
6. I own a Rigblaster Pro, and have not used the Tigertronics product; thus I have a built in bias towards the Rigblaster products. The Pros and Cons section is based on what I think the best and worst features are for all products mentioned.
7. MixW http://www.mixw.com
8. MT-63 Terminal http://www.geocities.com/iz8bly/MT63/
9. MT-63 Web Site: http://www.qsl.net/zl1bpu/MT63/MT63.html
10. More on MT63: A publication of Navy MARS
11. MT63: A high Reliability Mode for MARS Digital Communications by Davis and Johnson
12. Getting started with RTTY http://aa5au.com/gettingstarted/rtty_start_intro.htm
13. RTTY Basics by W7TI: http://www.ok1rr.com/view.php?cisloclanku=2005021501
14. I am looking for more information on these units, please mail comments to nnn0rdo@navymars.org
15. Simple descriptions of digital modes, common and uncommon: http://www.qsl.net/zl1bpu/FUZZY/digital.html
16. Setting up MMSSTV by Dave Cole, NK7Z: http://www.nk7z.net/mmsstv/index.shtml